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Kim

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(54) **LIGHTING DEVICE**

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(51) **Int. Cl.**

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F21V 29/02	(2006.01)
F21K 99/00	(2010.01)
F21V 29/65	(2015.01)
F21V 29/83	(2015.01)
F21Y 105/00	(2006.01)
F21Y 101/02	(2006.01)
F21V 29/75	(2015.01)
F21V 29/76	(2015.01)
F21V 29/80	(2015.01)

(52) **U.S. Cl.**

CPC ***F21V 29/77*** (2015.01); ***F21K 9/137*** (2013.01); ***F21V 29/02*** (2013.01); ***F21V 29/40*** (2013.01); ***F21V 29/65*** (2015.01); ***F21V 29/83*** (2015.01); *F21V 29/75* (2015.01); *F21V 29/763* (2015.01); *F21V 29/80* (2015.01); *F21Y 2101/02* (2013.01); *F21Y 2105/001* (2013.01)

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CPC F21K 9/137; F21V 29/02; F21V 29/40; F21V 29/65; F21V 29/75; F21V 29/77; F21V 29/80; F21V 29/83; F21V 29/763; F21Y 2101/02; F21Y 2105/001

See application file for complete search history.

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(57) **ABSTRACT**

A lighting device may be provided that comprises: a light emitting module; a heat sink disposed on the light emitting module; a heat radiating fan disposed on the heat sink; and a housing which receives the light emitting module, the heat sink and the heat radiating fan, and includes an air inlet port and an air outlet port which are separated from each other and formed in a direction in which the lighting emitting module irradiates light, wherein the air inlet port and the air outlet port are disposed on the circumference of the housing, and wherein the air inlet port and the air outlet port are alternately disposed.

20 Claims, 12 Drawing Sheets

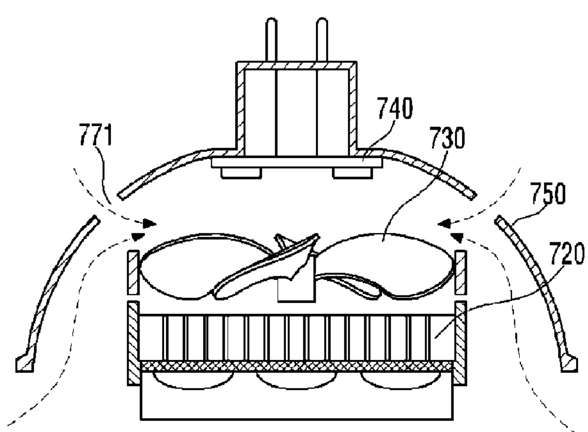


Fig.1

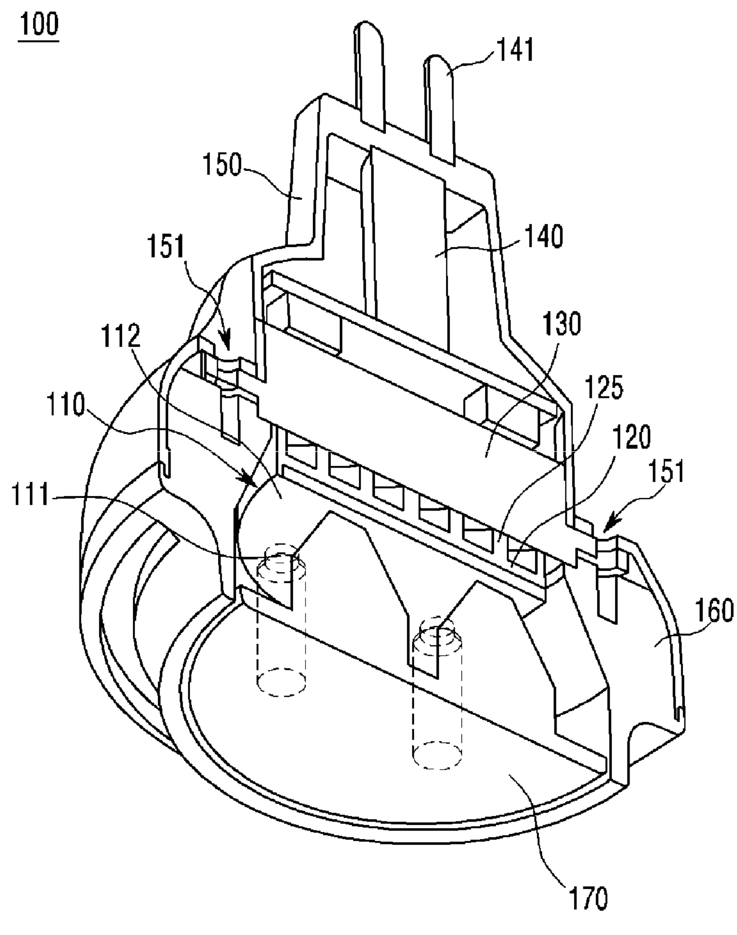


Fig.2

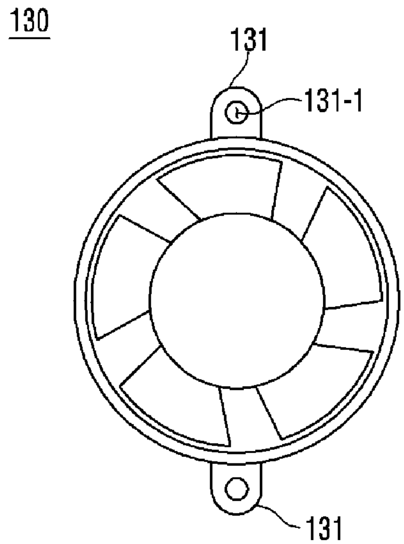


Fig.3

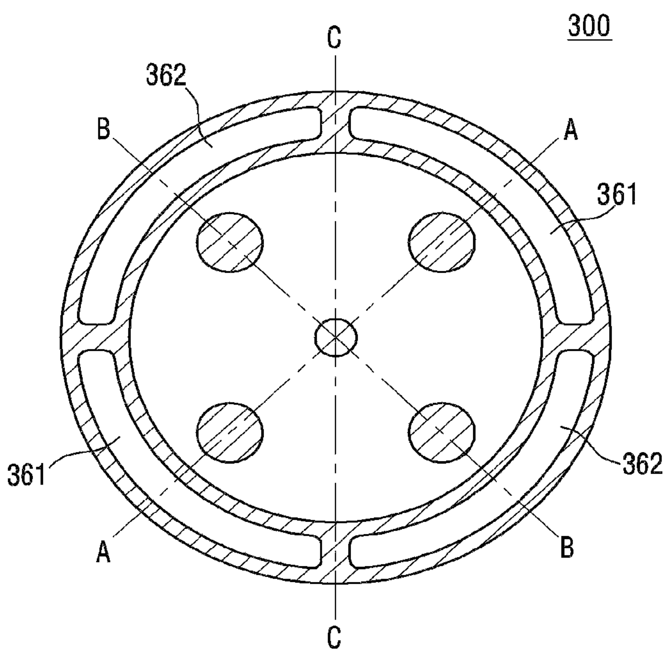


Fig.4

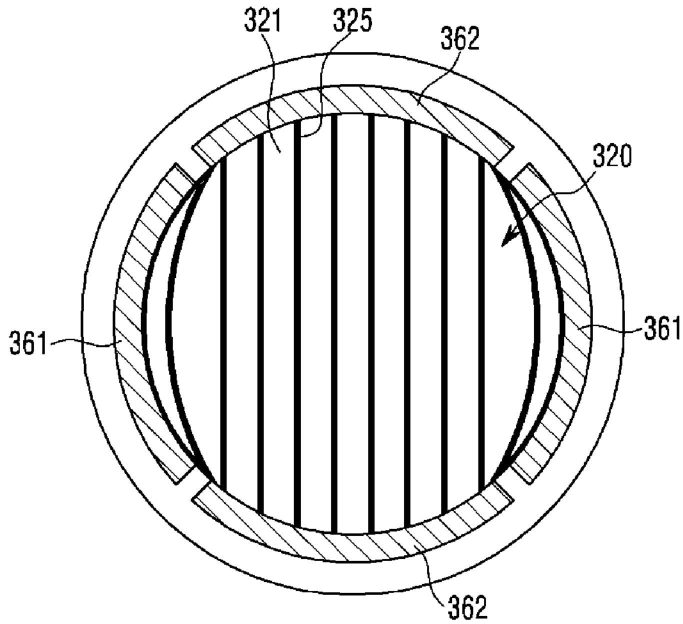
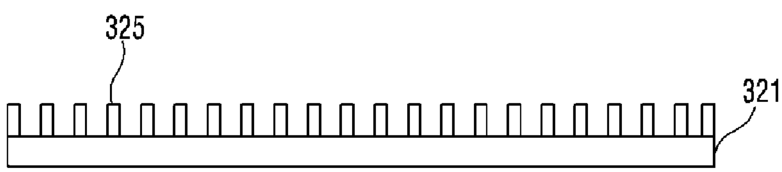
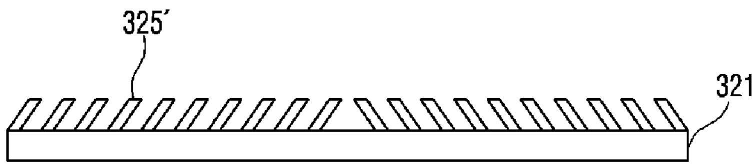


Fig.5

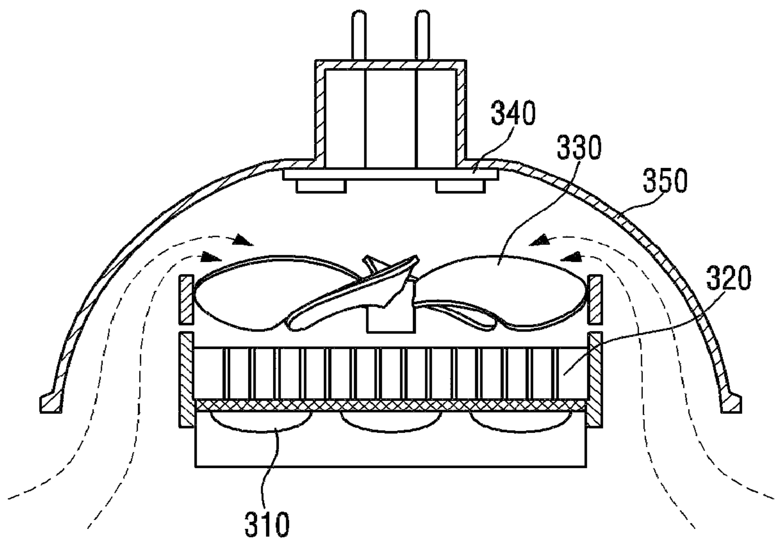


(A)



(B)

Fig.6



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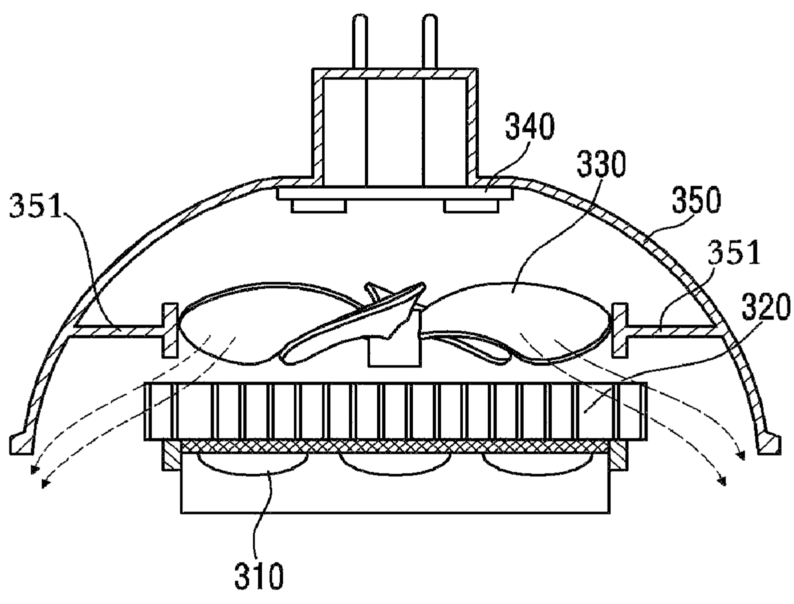


Fig.8

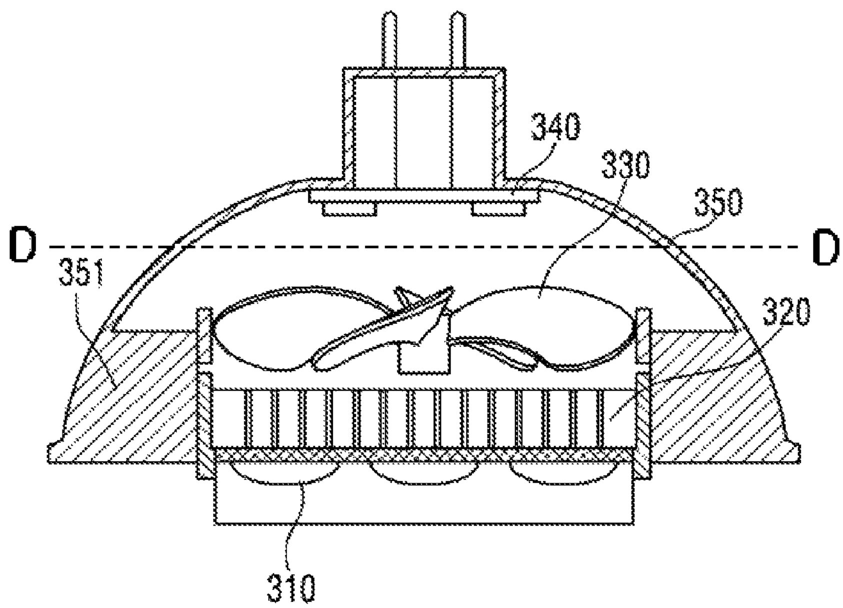


Fig.9

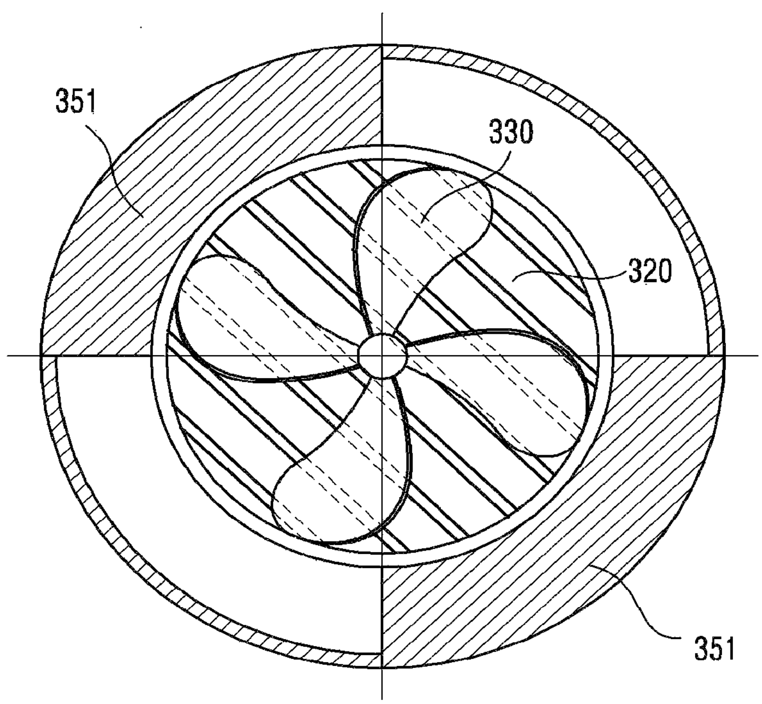


Fig.10

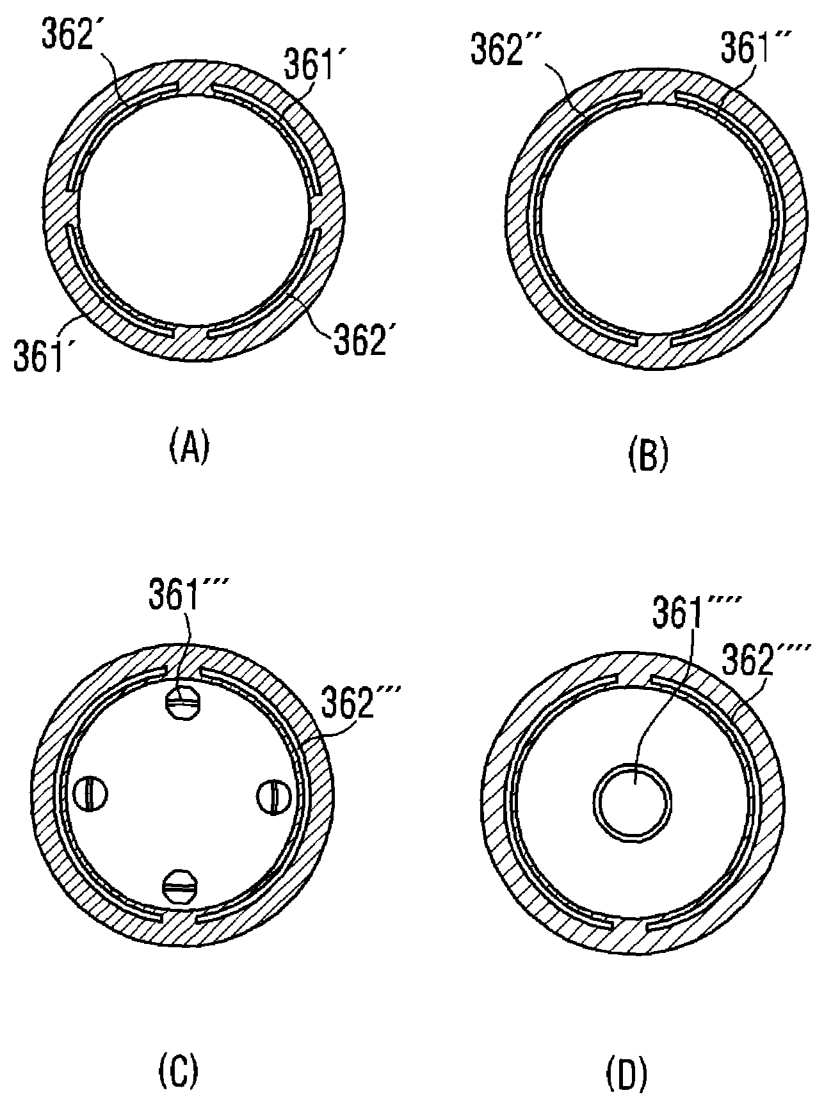


Fig.11

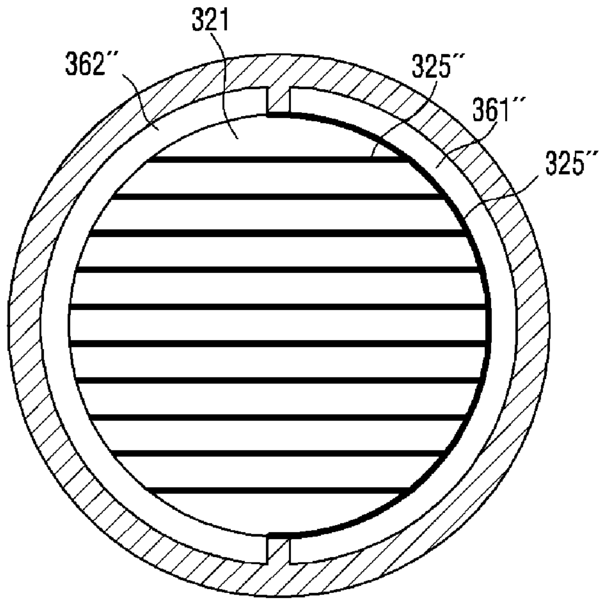


Fig.12

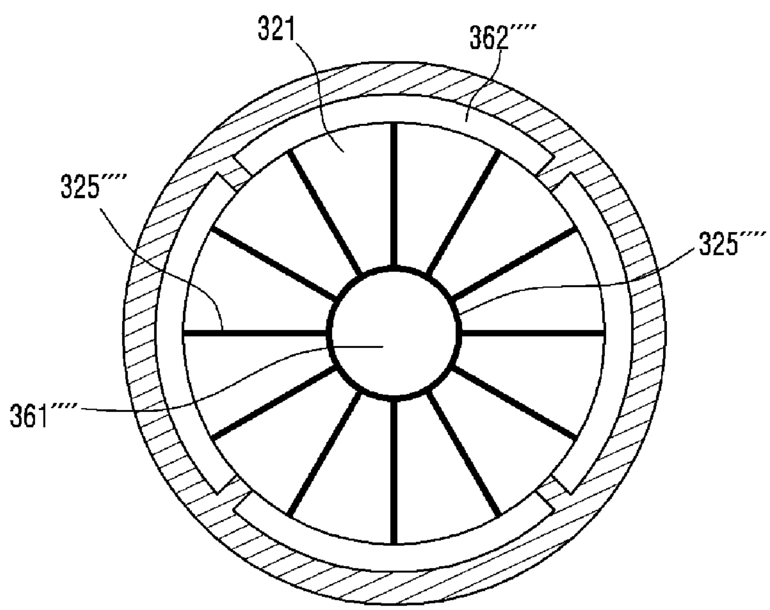


Fig.13

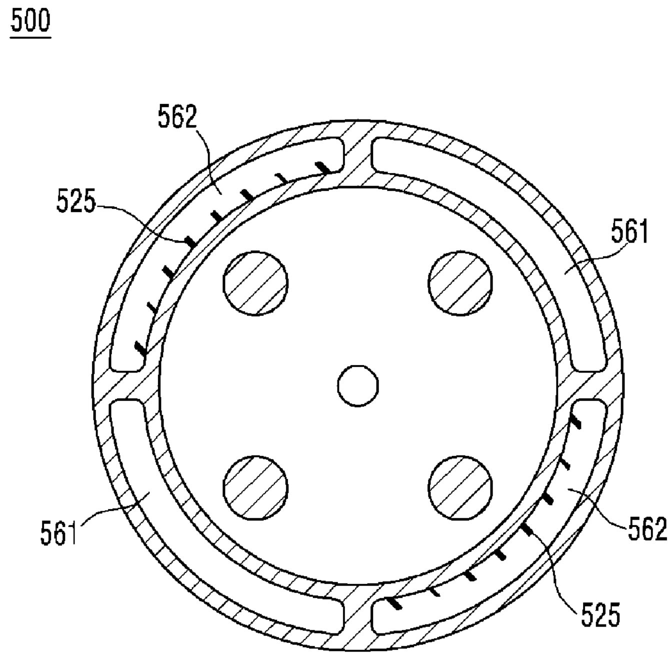


Fig.14

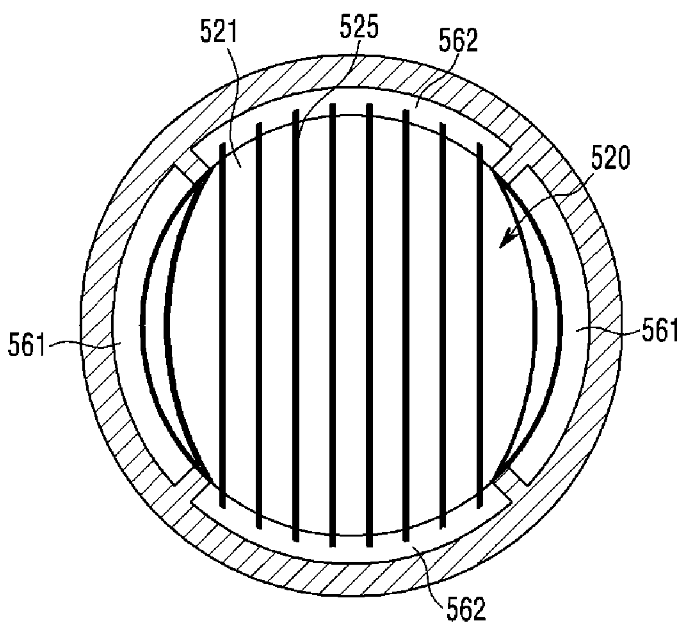


Fig.15

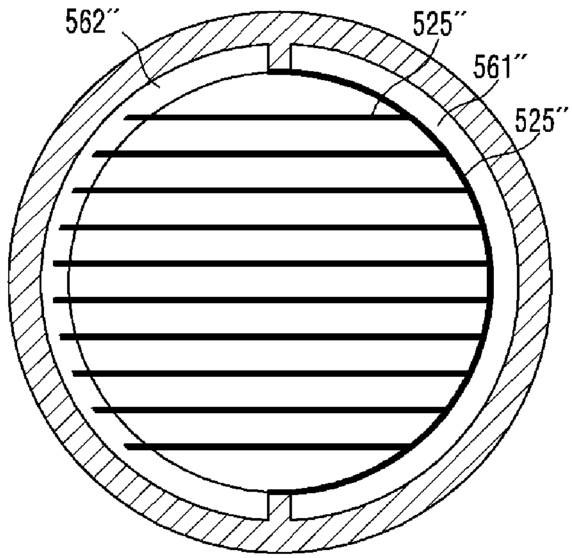


Fig.16

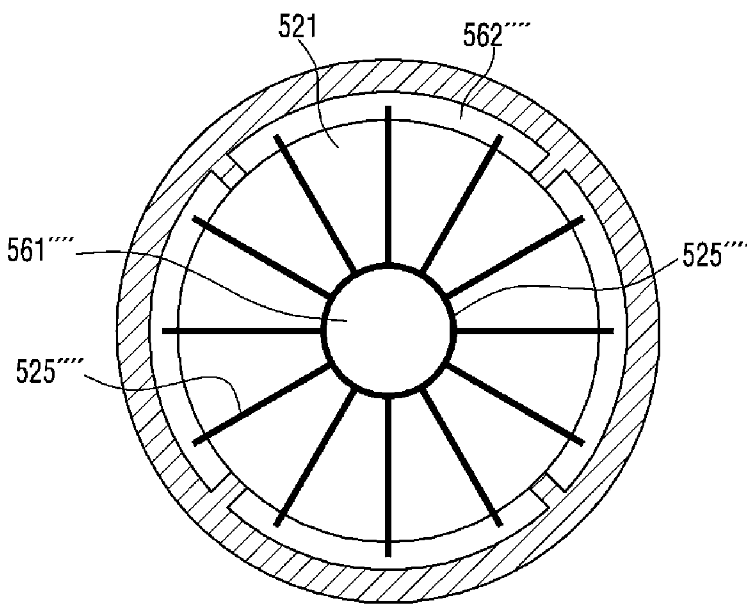


Fig.17

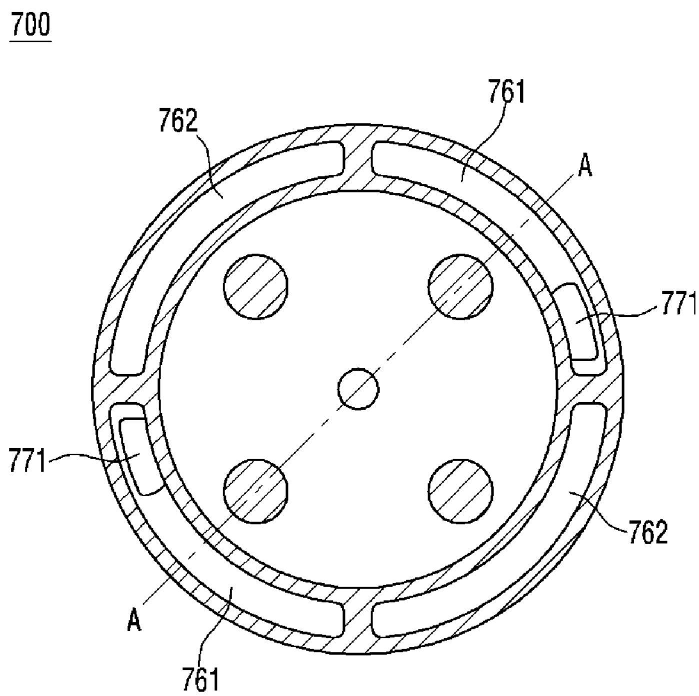


Fig.18

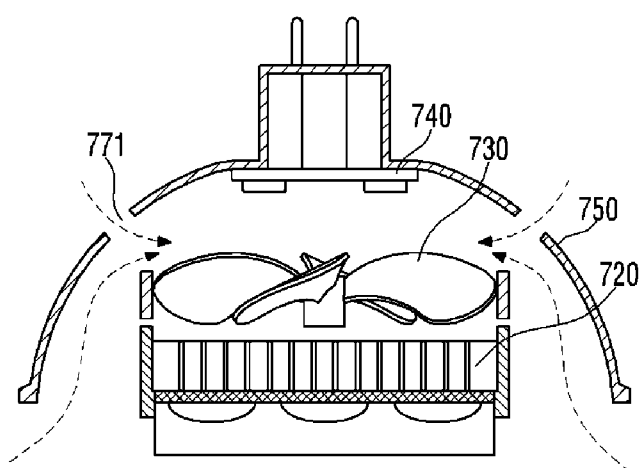


Fig.19

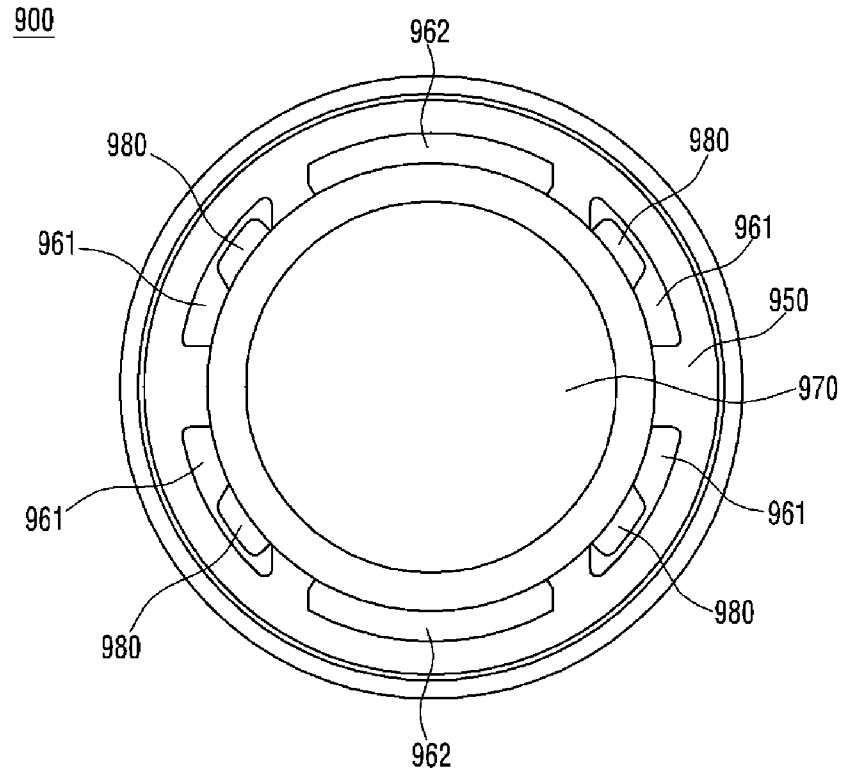


Fig.20

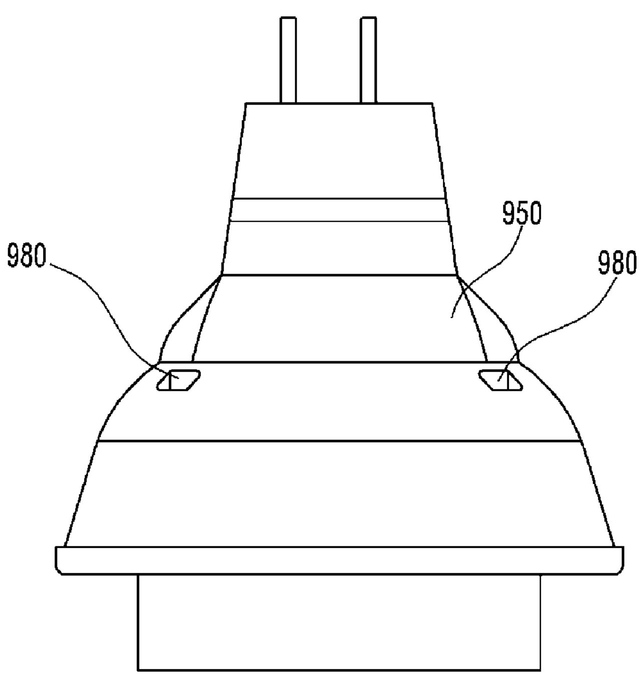
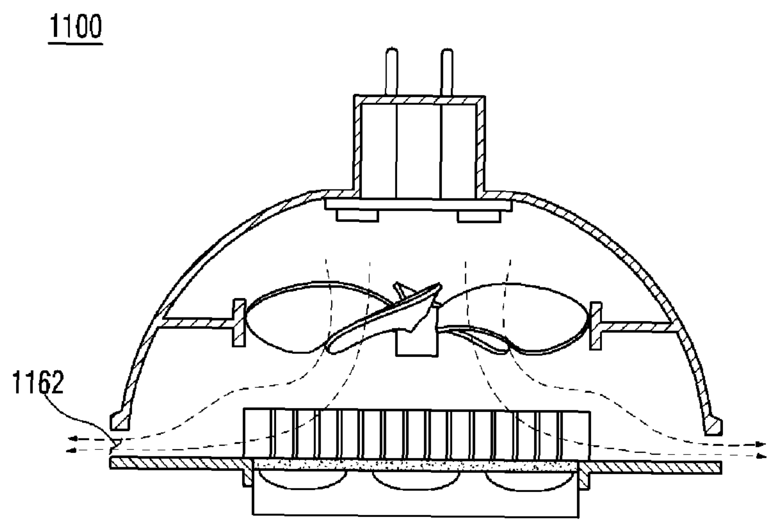


Fig.21



LIGHTING DEVICE

This application is a Continuation application of U.S. application Ser. No. 13/477,882 filed May 22, 2012, now U.S. Pat. No. 8,939,671, which claims priority from Korean Application No. 10-2011-0048243 filed May 23, 2011, No. 10-2011-0053485 filed Jun. 2, 2011, No. 10-2011-0057212 filed Jun. 14, 2011, and No. 10-2011-0057213 filed Jun. 14, 2011, the subject matters of which are incorporated herein by reference.

BACKGROUND

1. Field

Embodiments may relate to a lighting device.

2. Background

A light emitting diode (LED) is an energy device for converting electric energy into light energy. Compared with an electric bulb, the LED has higher conversion efficiency, lower power consumption and a longer life span. As there advantages are widely known, more and more attentions are now paid to a lighting device using the LED.

However, much heat is generated when the LED is lighted. Further, when the heat is not readily radiated, the life span of the LED becomes shorter, illuminance is degraded and quality characteristic is remarkably deteriorated. Therefore, advantages of the LED light device can be obtained under the condition that the heat of the LED is easily radiated.

SUMMARY

One embodiment is a lighting device. The lighting device includes: A lighting device may be provided that comprises: a light emitting module; a heat sink disposed on the light emitting module; a heat radiating fan disposed on the heat sink; and a housing which receives the light emitting module, the heat sink and the heat radiating fan, and includes an air inlet port and an air outlet port which are separated from each other and formed in a direction in which the lighting emitting module irradiates light, wherein the air inlet port and the air outlet port are disposed on the circumference of the housing, and wherein the air inlet port and the air outlet port are alternately disposed.

Another embodiment is a lighting device. The lighting device includes: a light emitting module; a heat sink disposed on the light emitting module; a heat radiating fan disposed on the heat sink; and a housing which receives the light emitting module, the heat sink and the heat radiating fan, and includes an air inlet port and an air outlet port which are separated from each other and formed in a direction in which the lighting emitting module irradiates light, wherein the air inlet port is disposed closer to the center of the housing than the air outlet port.

Further another embodiment is a lighting device. The lighting device includes: a light emitting module; a heat sink disposed on the light emitting module; a heat radiating fan disposed on the heat sink; and a housing which receives the light emitting module, the heat sink and the heat radiating fan, and includes an air inlet port and an air outlet port, wherein the heat sink comprises a base plate and a plurality of heat radiating fins extended from the base plate, wherein the heat radiating fan injects an air provided from the air inlet port into the heat sink, and wherein the heat radiating fins guide the air to the outlet port of the housing.

BRIEF DESCRIPTION OF THE DRAWINGS

Arrangements and embodiments may be described in detail with reference to the following drawings in which like reference numerals refer to like elements and wherein:

FIG. **1** is a sectional perspective view of a lighting device according to an embodiment of the present invention;

FIG. **2** is a plan view of a heat radiating fan shown in FIG. **1**;

FIG. **3** is a bottom plan view of a lighting device according to another embodiment of the present invention;

FIG. **4** is a plan view of a heat sink of the lighting device according to the another embodiment of the present invention;

FIG. **5** is a cross sectional view of the heat sink shown in FIG. **4**;

FIG. **6** is a cross sectional view of FIG. **3** taken along line A-A;

FIG. **7** is a cross sectional view of FIG. **3** taken along line B-B;

FIG. **8** is a cross sectional view of FIG. **3** taken along line C-C;

FIG. **9** is a cross sectional view of FIG. **8** taken along line D-D;

FIG. **10** is a view showing modified examples of an air inlet port and an air outlet port which are shown in FIG. **3**;

FIG. **11** is a plan view of the heat sink of (B) of FIG. **10**;

FIG. **12** is a plan view of the heat sink of (D) of FIG. **10**;

FIG. **13** is a bottom plan view of a lighting device according to further another embodiment of the present invention;

FIG. **14** is a plan view of a heat sink of the lighting device according to the further another embodiment of the present invention;

FIG. **15** is a view showing a modified example of the heat sink shown in FIG. **11**;

FIG. **16** is a view showing a modified example of the heat sink shown in FIG. **12**;

FIG. **17** is a bottom plan view of a lighting device according to yet another embodiment of the present invention;

FIG. **18** is a cross sectional view of FIG. **17** taken along line A-A;

FIG. **19** is a bottom plan view of a lighting device according to still another embodiment of the present invention;

FIG. **20** is a side view of the lighting device shown in FIG. **19**; and

FIG. **21** is a cross sectional view of a lighting device according to still another embodiment of the present invention.

DETAILED DESCRIPTION

A thickness or a size of each layer may be magnified, omitted or schematically shown for the purpose of convenience and clearness of description. The size of each component may not necessarily mean its actual size.

It should be understood that when an element is referred to as being 'on' or "under" another element, it may be directly on/under the element, and/or one or more intervening elements may also be present. When an element is referred to as being 'on' or 'under', 'under the element' as well as 'on the element' may be included based on the element.

An embodiment may be described in detail with reference to the accompanying drawings.

FIG. **1** is a sectional perspective view of a lighting device according to an embodiment of the present invention.

A lighting device **100** according to an embodiment of the present invention may include a light emitting module **110**, a heat sink **120** which is coupled to the light emitting module **110** and includes a heat radiating fin, a heat radiating fan **130** disposed on the heat sink **120**, an upper case **150** covering the heat radiating fan **130**, a driving unit **140** which is electrically connected to an LED mounting substrate **112** and the heat radiating fan **130** disposed within the upper case **150**, and supplies electric power, and a lower case **160** coupled to the upper case **150** and fixes the light emitting module **110**.

Each component will be described in detail as follows.

<Light Emitting Module>

The light emitting module **110** may include at least one LED **111** and the LED mounting substrate **112** on which the LEDs **111** are disposed.

A plurality of the LEDs **111** may be disposed on the LED mounting substrate **112**. The number and arrangement of the LEDs **11** to be disposed can be freely adjusted depending on a required illuminance. The light emitting module **110** may be formed in the form of a plurality of the collected LEDs **111** such that it can be easily handled and advantageously produced.

The LED mounting substrate **112** may be formed by printing a circuit pattern in an insulator. For example, the LED mounting substrate **112** may include not only a printed circuit board (PCB), a metal core PCB, a flexible PCB and a ceramic PCB, but also a chips on board (COB) allowing an unpackaged LED chip to be directly bonded thereon. The LED mounting substrate **112** may be formed of a material which efficiently reflects light. The surface of the LED mounting substrate **112** may have a color capable of efficiently reflecting light, for example, white, silver and the like.

The LED **111** disposed on the LED mounting substrate **112** may be at least one of a red LED, green LED, blue LED or white LED, each of which emits red, green, blue or white light respectively. There is no limit to the kind and the number of the LEDs **111**.

<Heat Sink>

The heat sink **120** is disposed on the light emitting module **110** and is able to receive and radiate heat generated from the light emitting module **110**.

The surface of the heat sink **120** may have a plurality of heat radiating fins **125**. A plurality of the heat radiating fins **125** may be radially disposed along the surface of the heat sink **120**. A plurality of the heat radiating fins **125** increases the surface area of the heat sink **120**, thereby improving the heat radiation efficiency of the heat sink **120**.

The heat sink **120** allows air injected from the heat radiating fan **130** into the heat sink **120** to pass the surface of the heat sink **120** and to be emitted through an air outlet port of the lower case **160**. The heat sink **120** may include the heat radiating fins **125** which are arranged in a certain direction. For example, the heat radiating fins **125** of the heat sink **120** may be arranged both perpendicular to a direction of the air injected from the heat radiating fan **130** and toward the air outlet port of the lower case **160**.

The arrangement direction and disposition of the heat radiating fins **125** will be described in more detail in FIGS. **3** and **4**.

The heat sink **120** is separated from an air inlet port and disposed to be exposed by the air outlet port. As a result, air coming into the lighting device **100** according to the embodiment is maintained to have a normal temperature, and air which is emitted comes in contact with the heat sink **120** as much as possible. Therefore, the lighting device **100** according to the embodiment radiates the heat of the heat sink **120** to the outside by using the air which is emitted through the air outlet port. Here, the heat sink **120** may be separated from the air inlet port by a partition within the lower case **160**.

The heat sink **120** may be formed of a metallic material or a resin material which has high heat radiation efficiency. The material of the heat sink **120** is not limited. For example, the material of the heat sink **120** may include at least one of Al, Ni, Cu, Ag and Sn.

Though not shown in the drawing, a heat radiating plate (not shown) may be disposed between the light emitting module **110** and the heat sink **120**. The heat radiating plate (not shown) may be formed of a thermal conduction silicon pad or a thermal conductive tape which has a high thermal conductivity. The heat radiating plate is able to effectively transfer the heat generated from the light emitting module **110** to the heat sink **120**.

<Heat Radiating Fan>

FIG. **2** is a plan view of a heat radiating fan **130** shown in FIG. **1**.

Referring to FIGS. **1** and **2**, the heat radiating fan **130** is disposed on the heat sink **120**. The heat radiating fan **130** is able to perform a function of reducing the heat within the lighting device **100** by forcedly generating convection of the air within the lighting device **100**.

When electric power is applied to the lighting device **100**, light is emitted and much heat is generated from the light emitting module **110**. The heat radiating fan **130** functions to reduce the much heat generated from the light emitting module **110**.

The heat radiating fan **130** may be driven simultaneously with the driving of the light emitting module **110**, or may be driven only when a temperature within the lighting device **100** is equal to or higher than a predetermined temperature. Here, the temperature within the lighting device **100** may be detected by using a thermal sensor.

When the heat radiating fan **130** is operated, external air is inhaled through the air inlet port of the lower case **160**. The inhaled air passes through the heat radiating fan **130**. The air which has passed through the heat radiating fan **130** exchanges the heat with the heat sink **120** while passing through the heat sink **120**. Then, the air heated through the heat exchange may be emitted through the air outlet port of the lower case **160**.

Also, since the heat radiating fan **130** is disposed separately from the heat sink **120**, it is possible to obtain a space allowing the air emitted from the heat radiating fan **130** to sufficiently flow.

In a detailed embodiment, the lighting device **100** may be "MR16". When the lighting device **100** is MR16, the external diameter of MR16 may be 50 mm and the diameter of the heat radiating fan **130** may be 30 mm. According to the shape of MR16 formed in the form of a hemisphere, since the width of the lighting device **100** increases with the approach to the lower portion thereof, the heat sink **120** may be formed to have its maximum size for the heat radiation and may have a diameter larger than that of the heat radiating fan **130**.

The air may be directly injected from the heat radiating fan **130** to only some surfaces of the heat sink **120**. Also, as mentioned in the description of the heat sink **120**, the arrangement of the heat radiating fins **125** may be specified in such a manner that the injected air passes all of the surfaces of the heat sink **120**.

A coupler **131** may be disposed on the outside of the heat radiating fan **130** such that the heat radiating fan **130** is coupled to the upper case **150**. The coupler **131** may be extended outwardly from one side or both sides of the heat radiating fan **130**. The coupler **131** may have a hole **131-1** into which a screw is inserted.

<Upper Case and Lower Case>

The upper case **150** covers the outside of the heat radiating fan **130** and is coupled to the lower case **160**, so that the upper case **150** may include an air path allowing the air introduced into the lighting device **100** to be emitted along a certain path.

A terminal **141** for supplying electric power may be disposed on the outside of the upper case **150**.

The driving unit **140** may be disposed within the upper case **150**. The driving unit **140** is electrically connected to the heat radiating fan **130** and the light emitting module **110**, and supplies electric power supplied from the terminal **141** to the heat radiating fan **130** and the light emitting module **110**.

The driving unit **140** may be formed by mounting various electronic components for driving the LED **111** on the PCB. Here, the terminal **141** is mounted on the top surface of the PCB. The terminal **141** penetrates the upper case **150**, so that the terminal **141** is partially exposed upward. The terminal **141** can be electrically connected to an external electrical outlet by using the exposed part of the terminal **141**.

The terminal **141** may be formed in the form of a pin inserted close to the rear end of the upper case **150** (shown with two terminals in the drawing). However, the shape of the terminal **141** is not limited to this. The terminal **141** functions as an entrance for receiving an electric power from an external power supply (a DC power supply is assumed, however, the terminal **141** may accept an AC power supply and include either a rectifier or a condenser disposed therein) to the lighting device of the present invention.

The upper case **150**, the heat radiating fan **130** and the lower case **160** may respectively have a common hole **151**. Two holes **151** may be provided. The upper case **150**, the heat radiating fan **130** and the lower case **160** may be coupled to each other by fastening a screw into the two holes **151**.

When the screw is fastened into the two holes **151**, the lower case **160** is able to hold and fix the outer portion of the light emitting module **110**. Also, a space for receiving the light emitting module **110** is formed in the lower case **160**, so that the light emitting module **110** may be disposed in the receiving space of the lower case **160**.

The lower case **160** may include the air inlet port and the air outlet port which are formed in a direction in which the lighting device **100** irradiates light. The air inlet port and the air outlet port are configured and disposed independently of each other. The air inlet port may be used to allow external air to be introduced into the lighting device **100**. The air outlet port may be used to allow the air processed by the heat exchange within the lighting device **100** to be emitted therethrough.

Regarding the air path of the lighting device **100** according to the embodiment, the air outside the lighting device **100** is introduced into a space between the upper case **150** and the heat radiating fan **130** through the air inlet port of the lower case **160**, and then is inhaled into the heat radiating fan **130** by the operation of the heat radiating fan **130** and is injected into the space between the heat radiating fan **130** and the heat sink **120**. The injected air cools the heat sink **120** through the heat exchange with the heat sink **120**, and then is emitted through the air outlet port of the lower case **160**.

The upper case **150** or the lower case **160** may include a partition in order to distinguish between the air introduction path through the air inlet port and the air emission path through the air outlet port.

When the lighting device **100** according to the embodiment is used buried in a wall or a ceiling, since the air inlet port and the air outlet port are not placed in a buried portion of the lighting device **100** but placed in externally exposed portion of the lighting device **100**, the external air can be effectively introduced and emitted.

A lens **170** may be disposed in the lower case **160**. The lens **170** is formed over the LEDs **111** and may collect light emitted from the LEDs **111** or distribute at a predetermined angle. The lens **170** may protect the LEDs **111** from external impact.

FIG. **3** is a bottom plan view of a lighting device **300** according to another embodiment of the present invention. FIG. **4** is a plan view of a heat sink of the lighting device **300** according to the another embodiment of the present invention. FIG. **5** is a cross sectional view of the heat sink shown in FIG. **4**. FIG. **6** is a cross sectional view of FIG. **3** taken along line A-A. FIG. **7** is a cross sectional view of FIG. **3** taken along line B-B. FIG. **8** is a cross sectional view of FIG. **3** taken along line C-C. FIG. **9** is a cross sectional view of FIG. **8** taken along line D-D.

Referring to FIGS. **3** to **9**, the lighting device **300** according to the another embodiment of the present invention may include a light emitting module **310**, a heat sink **320** disposed on the light emitting module **310**, a heat radiating fan **330** disposed on the heat sink **320**, and a housing **350** receiving the light emitting module **310**, the heat sink **320** and the heat radiating fan **330**.

The light emitting module **310**, the heat sink **320** and the heat radiating fan **330** may be the same as the light emitting module **110**, the heat sink **120** and the heat radiating fan **130** of the lighting device **100** according to the embodiment shown in FIGS. **1** and **2**.

Unlike the lighting device **100** according to the embodiment shown in FIG. **1**, the lighting device **300** according to the another embodiment includes the housing **350** receiving the light emitting module **310**, the heat sink **320** and the heat radiating fan **330**. Here, the housing **350** may be divided into the upper case **150** and the lower case **160** of the lighting device **100** according to the embodiment shown in FIG. **1**, or may be integrally formed.

A driving unit **340** is disposed within the housing **350** and supplies external electric power to the heat radiating fan **330** and the light emitting module **310**.

An air inlet port **361** and an air outlet port **362** may be formed in the lower portion of the housing **350**, that is to say, a portion of the housing **350**, through which light is emitted from the light emitting module **310**. An air path may be formed in the housing **350** in such a manner that the air introduced from the air inlet port **361** passes through the heat radiating fan **330**, and then the air which has passed through the heat radiating fan **330** passes by the heat sink **320** and is emitted through the air outlet port **362**. The air path connected to the air inlet port **361** and the air outlet port **362** may be separated from each other by the heat radiating fan **330** and a partition **351** within the housing **350**.

Referring to FIG. **4**, the heat sink **320** may include a base plate **321** and heat radiating fins **325** disposed on the base plate. The heat radiating fins **325** may be arranged toward the air outlet port **362** and may be disposed to blocks the air inlet port **361** lest the air introduced into the heat sink **320** by the heat radiating fan **330** should be emitted through the air inlet port **361**. As a result of this, the air emitted from the heat radiating fan **330** is emitted through the air outlet port **362** without moving toward the air inlet port **361**.

As described above, the air introduced from the heat radiating fan **330** by the arrangement of the heat radiating fins **325** passes the entire surface of the heat sink **325** and is emitted only through the air outlet port **362**. As a result, heat dissipation efficiency of the entire heat sink **320** is improved and the air flow can be appropriately controlled.

The partition **351** within the lighting device may prevent the air emitted from the heat radiating fan **330** from flowing toward the air inlet port **361**.

As shown in (A) of FIG. **5**, the heat radiating fins **325** may be disposed perpendicular to the base plate **321**. Here, when the heat radiating fins **325** are perpendicular to the base plate **321**, the air emitted from the heat radiating fan **330** collides with and reflects from the heat sink **320**, and moves toward the heat radiating fan **330**, and then may function as a force causing the heat radiating fan **330** to be operated in a reverse direction. To overcome this problem, as shown in (B) of FIG. **5**, heat radiating fins **325'** may not be disposed perpendicular to the base plate **321** but be obliquely disposed toward the center of the base plate **321**. When the heat radiating fins **325'** are obliquely disposed toward the center of the base plate **321**, the air emitted from the heat radiating fan **330** is introduced between the heat radiating fins **325'** and is reflected to the heat radiating fan **330**. Here, the amount of the reflected air may be notably reduced. Accordingly, the force opposing the driving force of the heat radiating fan **330** is reduced and the heat radiating fan **330** can be more efficiently driven.

Referring to FIG. **6**, shown is an air introduction path of the lighting device **300** according to the another embodiment. Due to the operation of the heat radiating fan **330**, the air outside the lighting device **300** passes through the air inlet port **361** and moves to a space between the housing **350** and the upper portion of the heat radiating fan **330**. According to the embodiment shown in FIG. **1**, when the heat radiating fan **130** is operated, the outside air would move to a space between the upper case **150** and the upper portion of the heat radiating fan **130**.

The heat sink **320** may be separated from the air introduction path. As a result, the air introduced from the air inlet port **361** maintains its temperature to be a normal temperature without contact with the heat sink **320** and is introduced into the lighting device **300**. If the introduced air first contacts with the heat sink **320**, heated air is introduced into the space between the housing **350** and the upper portion of the heat radiating fan **330**, so that the driving unit **340** may not be effectively cooled.

The introduced air is maintained to have a normal temperature and is moved to the space between the housing **350** and the upper portion of the heat radiating fan **330**. Then, the driving unit **340** can be cooled through the heat exchange between the air and the driving unit **340** of the lighting device **300**.

Referring to FIG. **7**, shown is an air emission path of the lighting device **300** according to the another embodiment. As shown in FIG. **7**, the air introduced into the upper portion of the heat radiating fan **330** is injected into a space between the lower portion of the heat radiating fan **330** and the heat sink **320** by the operation of the heat radiating fan **330**. The injected air passes the surface of the heat sink **320** and exchanges heat with the heat sink **320**, thereby cooling the heat sink **320** which has received the heat from the light emitting module **310**.

Referring to FIGS. **8** and **9**, the inside of the housing **350**, which corresponds to the air outlet port **362**, is blocked with the partition **351**. Therefore, the air heated by the heat sink **320** does not come into the lighting device **300** but is emitted to the outside of the lighting device **300** by the operation of the heat radiating fan **330**.

FIG. **10** is a view showing modified examples of an air inlet port and an air outlet port which are shown in FIG. **3**.

As shown in (A) and (B) of FIG. **10**, air inlet ports **361'** and **361"** and air outlet ports **362'** and **362"** may be formed on the circumference of the housing (or the lower case) in the form of a circular are.

In (A) of FIG. **10**, shown is a case where the air inlet port **361'** and the air outlet port **362'** are alternately formed on the circumference of the housing. Here, "the circumference of the housing" means the edge of the housing. How far the air inlet port **361'** and the air outlet port **362'** are formed from the center of the housing may be freely determined depending on the type of the embodiment of the present invention. As shown in (A) and (B) of FIG. **10**, the air inlet port **361** and the air outlet port **362** may be formed in the form of a circular arc forming a concentric circle with the circular housing.

As shown in (C) of FIG. **10**, an air inlet port **361'"** may be disposed more inside than an air outlet port **362'"**. As shown in (D) of FIG. **10**, an air inlet port **361""** may be disposed at the center of the housing and an air outlet port **362""** may be disposed on the circumference of the housing. The air inlet port **361""** and the air outlet port **362""** may have various shapes such as a circle, a polygon and the like as well as the circular arc. As shown in (C) and (D) of FIG. **10**, when the air inlet ports **361'"** and **361""** are disposed more inside than the air outlet ports **362'"** and **362""**, it is possible to reduce a probability that the heated air emitted through the air outlet ports **362'"** and **362""** is reintroduced through the air inlet ports **361'"** and **361""**.

FIG. **11** is a plan view of the heat sink of (B) of FIG. **10**. FIG. **12** is a plan view of the heat sink of (D) of FIG. **10**.

Referring to FIGS. **11** and **12**, heat radiating fins **325"** and **325'"** disposed on the base plate **321** are disposed to prevent the air from flowing out through the air inlet ports **361"** and **361""** and to cause the air to be emitted through the air outlet ports **362"** and **362""**.

FIG. **13** is a bottom plan view of a lighting device **500** according to further another embodiment of the present invention. FIG. **14** is a plan view of a heat sink **520** of the lighting device **500** according to the further another embodiment of the present invention.

Referring to FIGS. **13** and **14**, the lighting device **500** according to the further another embodiment of the present invention, like the lighting device **300** according to the another embodiment shown in FIGS. **3** to **4**, includes an air inlet port **561**, an air outlet port **562** and a heat sink **520**. The heat sink **520** includes a base plate **521** and heat radiating fins **525** disposed on the base plate **521**.

The heat radiating fins **525** of the lighting device **500** according to the further another embodiment are different from those of the lighting device **300** according to the another embodiment.

Some parts of the heat radiating fin **525** of the lighting device **500** according to the further another embodiment are extended to the air outlet port **562**. Specifically, the end portion of the heat radiating fin **525** is located in the air outlet port **562**. Therefore, the end portion of the heat radiating fin **525** is exposed outward by the air outlet port **562**. Through this, the heat radiating fin **525** is able to more efficiently exchange heat with the outside air.

FIG. **15** is a view showing a modified example of the heat sink shown in FIG. **11**. FIG. **16** is a view showing a modified example of the heat sink shown in FIG. **12**.

FIGS. **15** and **16** show the heat sink to which the heat radiating fins **525** of the lighting device **500** shown in FIGS. **13** and **14** are applied. Specifically, the end portions of the heat radiating fins **525"** and **525""** are disposed in the air outlet port **562"** and **562""**.

FIG. **17** is a bottom plan view of a lighting device **700** according to yet another embodiment of the present invention. FIG. **18** is a cross sectional view of FIG. **17** taken along line A-A.

Referring to FIGS. **17** and **18**, in the lighting device **700** according to yet another embodiment, an upper air inlet port **771** may be formed in the upper surface of the housing **750**, i.e., the surface of the housing **750** above a heat radiating fan **730**. The upper air inlet port **771** may be disposed in the upper surface of the housing **750** perpendicularly corresponding to an air inlet port **761** formed in the lower surface of the housing **750**.

In the bottom plan view of the lighting device **700** according to the yet another embodiment, the upper air inlet port **771** formed in the upper surface of the housing **750** can be seen through the air inlet port **761** formed in the lower surface of the housing **750**.

In FIGS. **17** and **18**, shown is an air introduction path of the lighting device **700** according to the yet another embodiment. Due to the operation of the heat radiating fan **730**, the air outside the lighting device **700** passes through the air inlet port **761** and the upper air inlet port **771**, and moves to a space between the housing **750** and the upper portion of the heat radiating fan **730**.

Referring to FIG. **18**, a heat sink **720** may be separated from the air introduction path. As a result, the air introduced from the air inlet port **761** and the upper air inlet port **771** maintains its temperature to be a normal temperature without contact with the heat sink **720** and is introduced into the lighting device. If the introduced air first contacts with the heat sink, heated air is introduced into the space between the housing and the upper portion of the heat radiating fan, so that a driving unit **740** may not be effectively cooled. The introduced air is maintained to have a normal temperature and is moved to the space between the housing **750** and the upper portion of the heat radiating fan **730**. Then, the driving unit **740** can be cooled through the heat exchange between the air and the driving unit **740** of the lighting device **700**.

FIG. **19** is a bottom plan view of a lighting device **900** according to still another embodiment of the present invention. FIG. **20** is a side view of the lighting device **900** shown in FIG. **19**.

Referring to FIGS. **19** and **20**, the lighting device **900** according to the still another embodiment of the present invention includes the same components as those of the lighting device **300** according to the another embodiment. However, arrangements of the air inlet port and the air outlet port are different from those of the lighting device **300**. Therefore, the air inlet port and the air outlet port will be described below.

A lens **970**, an air inlet port **961** and an air outlet port **962** may be disposed in the lower portion of a housing **950**, that is to say, a portion of the housing **950**, through which light is emitted from the light emitting module.

The lighting device **900** according to the still another embodiment includes four air inlet ports **961** formed in the bottom surface of the housing **950** and two air outlet ports **962**.

An upper air inlet port **980** may be formed in the top surface of the housing **950**, i.e., the surface of the housing **950**, which corresponds to the upper portion of the heat radiating fan. The upper air inlet port **980** may be disposed perpendicularly corresponding to the position of the air inlet port **961** formed in the bottom surface of the housing **950**.

Therefore, as shown in FIG. **19**, the upper air inlet port **980** formed in the top surface of the housing **950** can be seen through the air inlet port **961** formed in the bottom surface of the housing **950**.

As shown in FIG. **20**, the upper air inlet port **980** may be formed in the top surface of the housing **950**. Since the upper air inlet port **980** is formed in addition to the air inlet port **961** formed in the bottom surface of the housing **950**, dust introduction is minimized by reducing an air introduction rate, and cooling effect of internal temperature of the lighting device is enhanced by increasing the amount of the air introduced at a normal temperature.

FIG. **21** is a cross sectional view of a lighting device according to still another embodiment of the present invention.

Referring to FIG. **21**, an air inlet port of a lighting device **1100** according to still another embodiment of the present invention is similar to that of the lighting device **300** according to the another embodiment. However, an air outlet port **1162** may be configured in such a manner as to emit the heated air in a horizontal direction.

Specifically, the air inlet port is disposed toward the lower portion of the lighting device **1000**, i.e., toward an area which the lighting device illuminates or in a direction in which light is emitted. The air outlet port **1162** may be disposed toward the outer circumference of the lighting device **1100**. In other words, the air outlet port **1162** may be disposed toward the outside of the lateral surface of the lighting device **1100** or may be disposed obliquely downward.

Since the air emitted through the air outlet port **1162** has a higher temperature than a normal temperature due to the heating thereof, the air tends to rise. Therefore, when the heated air is emitted horizontally to the lighting device **1100** (i.e., toward the outer circumference of the lighting device **1100**), the heated air can be more effectively prevented from being reintroduced than when the heated air is emitted perpendicular to the lighting device **1100** (i.e., toward the illumination area of the lighting device **1100**).

The following Table 1 shows a simulation result of an LED temperature and a case temperature in an MR16 lighting device with an atmosphere temperature of 25° C. and an applied power of 10 W. A case where only the heat sink is used is compared with cases of embodiments (a) to (d) including the air inlet port and the air outlet port and using the heat radiating fan.

TABLE 1

	LED temperature [° C.]	Case temperature [° C.]	Remark
Existing (heat sink only)	161.7	66.4	Atmosphere temperature: 25° C.
Embodiment (a)	145.1	75.1	Applied power: 10 W
Embodiment (b)	146.8	66.5	
Embodiment (c)	129.0	81.2	
Embodiment (d)	140.3	94.8	

Compared with the case where only the heat sink is used, it can be seen that in the case where the heat radiating fan is also used, the case temperature rises by 0.1° C. to 28° C., however, the LED temperature falls by 16° C. to 32° C.

The following Table 2 shows a result that an internal temperature in a case where the upper air inlet port is disposed in the housing or the top surface of the upper case and an internal temperature in a case where not disposed are tested at a normal temperature of 25□.

TABLE 2

Test Point Temp. (° C.)			
	Case	C.	Remark
Case 1	No Top cover Hole	89.5	Based on a normal temperature of 25° C.
Case 2	Top cover Hole	86.6	

As shown in Table 2, the internal temperature of the lighting device in the case where the upper air inlet port is disposed becomes lower.

Considering that the quality characteristic and life span of the LED is affected by the temperature of the LED, the lighting device according to the embodiments of the present invention shows remarkably improved quality characteristic and life span as compared with those of a prior lighting device which uses only the heat sink.

The lighting devices according to various embodiments described above include not only the heat sink and heat radiating fan, but also the air inlet port and the air outlet port which are disposed independently of each other. Accordingly, the cooling efficiency of the lighting device is improved.

The upper air inlet port is additionally disposed in the top surface of the housing as well as the bottom surface of the housing, so that dust introduction is minimized by reducing an air introduction rate. Further, air having a lower temperature is introduced into the top surface, so that the life spans of the driving unit and the fan may become longer.

The lighting devices according to various embodiments described above may be buried-type lighting devices. Also, when the lighting device is buried, the air inlet port and the air outlet port are disposed in externally exposed portion of the lighting device, so that the heat can be effectively exchanged with the external air having a normal temperature.

The lighting devices according to various embodiments described above may be used in a lighting lamp which emits light by collecting a plurality of LEDs. Particularly, in a structure which is buried in a wall or a ceiling and faces toward an illumination area, the lighting device may be used in a buried-type lighting device using the LED which is installed in the structure such that only the front the LED is exposed.

Any reference in this specification to "one embodiment," "an embodiment," "example embodiment," etc., means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the invention. The appearances of such phrases in various places in the specification are not necessarily all referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with any embodiment, it is submitted that it is within the purview of one skilled in the art to affect such feature, structure, or characteristic in connection with other ones of the embodiments.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. A lighting device comprising:

a light emitting module;

a heat sink disposed on the light emitting module;

a heat radiating fan disposed on the heat sink; and

a housing which receives the light emitting module, the heat sink and the heat radiating fan, and includes an air inlet port and an air outlet port which are separated from each other and formed in a direction in which the lighting emitting module irradiates light,

wherein the air inlet port and the air outlet port are disposed on the circumference of the housing, and

wherein the air inlet port and the air outlet port are alternately disposed.

2. The lighting device of claim **1**, wherein the housing includes a partition separating the air inlet port from the air outlet port, wherein the air inlet port is connected to a space between the heat radiating fan and the housing, and wherein the air outlet port is connected to a space between the heat sink and the heat radiating fan.

3. The lighting device of claim **1**, wherein the light emitting module comprises a substrate and a light emitting device disposed on the substrate, and wherein the air inlet port and the air outlet port are disposed adjacent to the light emitting module.

4. The lighting device of claim **1**, wherein the heat sink comprises:

a base plate disposed on the light emitting module; and

a plurality of heat radiating fins disposed on the base plate, wherein a plurality of the heat radiating fins guide air emitted from the heat radiating fan to the air outlet port.

5. The lighting device of claim **1**, wherein the housing comprises:

a lower case which receives the heat sink and the light emitting module; and

an upper case which receives the heat radiating fan and is coupled to the lower case.

6. The lighting device of claim **5**, further comprising a driving unit which is disposed on the heat radiating fan and is received by the upper case.

7. The lighting device of claim **5**, wherein the upper case, the lower case and the heat radiating fan respectively have a common hole, and wherein the upper case, the lower case and the heat radiating fan are coupled to each other by inserting a screw into the hole.

8. The lighting device of claim **5**, wherein the air inlet port of the housing comprises a first air inlet port and a second air inlet port, wherein the first air inlet port is disposed in the upper case, and the second air inlet port, together with the air outlet port, is disposed in the lower case.

9. The lighting device of claim **1**, wherein, by the operation of the heat radiating fan, air having a first temperature is introduced into the air inlet port and air having a second temperature is emitted to the air outlet port, and wherein the second temperature is higher than the first temperature.

10. A lighting device comprising:

a light emitting module;

a heat sink disposed on the light emitting module;

a heat radiating fan disposed on the heat sink; and

a housing which receives the light emitting module, the heat sink and the heat radiating fan, and includes an air inlet port and an air outlet port which are separated from each other and formed in a direction in which the lighting emitting module irradiates light,

wherein the air inlet port is disposed closer to the center of the housing than the air outlet port.

11. The lighting device of claim **10**, wherein the air inlet port is disposed at the center of the housing, and air outlet port is disposed on the circumference of the housing.

12. The lighting device of claim **10**, wherein the housing includes a partition separating the air inlet port from the air outlet port, wherein the air inlet port is connected to a space between the heat radiating fan and the housing, and wherein the air outlet port is connected to a space between the heat sink and the heat radiating fan.

13. The lighting device of claim **10**, wherein, by the operation of the heat radiating fan, air having a first temperature is introduced into the air inlet port and air having a second temperature is emitted to the air outlet port, and wherein the second temperature is higher than the first temperature.

14. A lighting device comprising:

a light emitting module;

a heat sink disposed on the light emitting module;

a heat radiating fan disposed on the heat sink; and

a housing which receives the light emitting module, the heat sink and the heat radiating fan, and includes an air inlet port and an air outlet port,

wherein the heat sink comprises a base plate and a plurality of heat radiating fins extended from the base plate,

wherein the heat radiating fan injects an air provided from the air inlet port into the heat sink, and

wherein the heat radiating fins guide the air to the outlet port of the housing.

15. The lighting device of claim **14**, wherein the heat radiating fins are disposed perpendicular to the base plate.

16. The lighting device of claim **14**, wherein the heat radiating fins are obliquely disposed toward the center of the base plate.

17. The lighting device of claim **14**, wherein the air inlet port and the air outlet port are separated from each other.

18. The lighting device of claim **14**, wherein at least one fin of the heat radiating fins blocks in order to not incoming the air onto the inlet port.

19. The lighting device of claim **14**, wherein a part of the heat radiating fin is extended to the air outlet port.

20. The lighting device of claim **14**, wherein a part of at least one of a plurality of the heat radiating fins is disposed to be exposed in the air outlet port.

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